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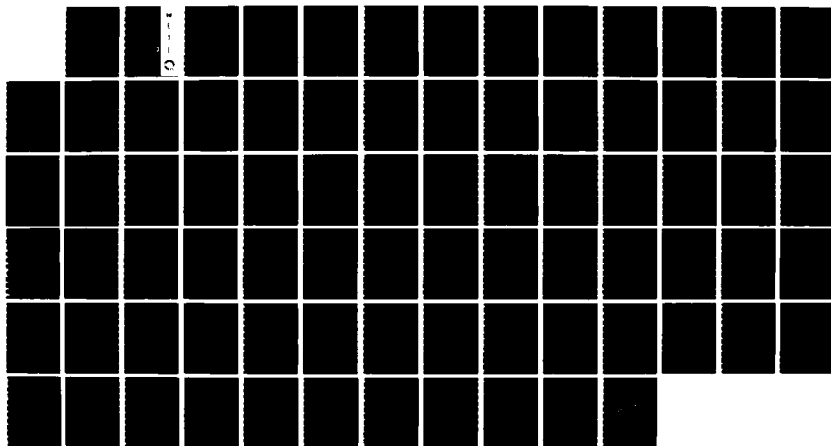
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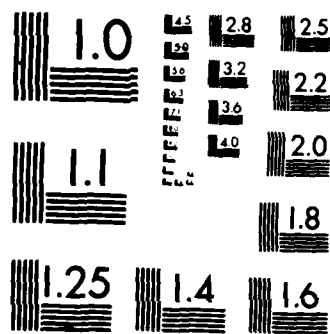
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XEROCOPY RESOLUTION TEST CHART  
NATIONAL BUREAU OF STANDARDS 1963-A

ETL - 0434

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Bibliography of in-house  
and contract reports,  
supplement 14

E. James Books  
Margaret F. Fox  
Alice L. Holmes

AD-A173 750

August 1986

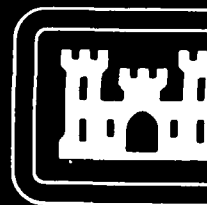


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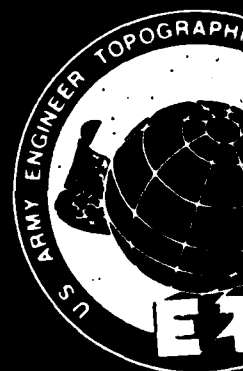
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Prepared for  
U.S. ARMY CORPS OF ENGINEERS  
ENGINEER TOPOGRAPHIC LABORATORIES  
FORT BELVOIR, VIRGINIA 22060-5546

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## PREFACE

This is Supplement 14 to the report titled, "Bibliography of In-House and Contract Reports" AD-877 653L; Supplement 1, AD-890 066L; Supplement 2, AD-905 548L; Supplement 3, AD-B005 275L; Supplement 4, AD-B010 6421; Supplement 5, AD-B019 966L; Supplement 6, AD-A055 468; Supplement 7, AD-A068 744; Supplement 8, AD-A084 111; Supplement 9, AD-A099 803; Supplement 10, AD-A113 006; Supplement 11, AD-A128 400; Supplement 12, AD-A141 778; and Supplement 13, AD-A160 607. It is a continuing bibliography of reports prepared by and for the U.S. Army Engineer Topographic Laboratories (USAETL), Fort Belvoir, Virginia. This bibliography includes reports that were published from 1 January 1985 through 31 December 1985.

Reports with AD numbers can be purchased by Department of Defense agencies from the Defense Technical Information Center; other agencies and individuals can purchase copies from the National Technical Information Service, Springfield, Virginia 22161. Reports with a "B" in the AD number are limited in distribution to U.S. Government agencies unless permission for release is granted from the controlling office. Reports are available on an interlibrary loan from the Scientific and Technical Information Center (STINFO), U.S. Army Engineer Topographic Laboratories, Fort Belvoir, Virginia 22060-5546.

COL Alan L. Laubscher, CE was Commander and Director, and Mr. Walter E. Boge was Technical Director of the Engineer Topographic Laboratories during the report preparation.



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## TEXTURE ANALYSIS AND CARTOGRAPHIC FEATURE EXTRACTION

January 1985

Rand, Robert S.

**Keywords:** Ad-Hoc Image Descriptor, Bayes Classifier, Bhattacharyya Distance, Clustering, Digital Image Analysis Laboratory (DIAL), Feature Extraction, Interactive Processing, Laws Texture Measure, Principal Components, Raster Processing, Relaxation

Investigations into using various image descriptors as well as developing interactive feature extraction software on the Digital Image Analysis Laboratory (DIAL) have culminated in a revised procedure to test statistical classification methods. An interactive experiment using this procedure was performed and showed that of the image descriptors tested, the most significant was a two-component vector derived from an average and a standard deviation measure of gray shades. The texture measures failed to deliver any increase in performance for the classifier. In general, this report shows that statistical classification methods are insufficient by themselves to deliver the performance needed in a semi-automated cartographic feature extraction system.

ETL-0371

AD-A156 735

## ANALYSIS OF EDGE DETECTION ALGORITHMS ON DIAL

January 1985

Brown, Jane M.

**Keywords:** Feature Extraction, Edge Detection, Nonlinear Edge Masks, Directional Edge Masks, Relaxation, Zero-Crossing (2nd Order Differential) Operator, Sobel, Marr Edge Detector, Prewitt Edge Masks, Kirsch Edge Masks

A study was conducted to determine whether selected edge-finding algorithms could be used in a semiautomated feature extraction system to find lineal features such as roads and boundaries. This research note analyzes and compares selected edge-finding algorithms, and comments on their integration with other feature classification algorithms.



**CULTURAL DATA BASE IMPLEMENTATION STUDY AND  
COMPUTER-AIDED SCENE MODELING SYSTEM USERS MANUAL**  
October 1984

Panton, D.J.  
Murphy, M.E.  
Grosch, C.B.

Control Data Corporation

DAAK70-81-C-0063

**Keywords:** Cultural Data Base, Digital Imagery, Photogrammetry, Software, Structures, Workstation

This report describes the software developed for cultural features data base generation as implemented in the Remote Work Processing Facility at the Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC). Manmade structures such as buildings, smokestacks, or storage tanks that appear on stereo pictures are measured by an operator and the measurements are combined by the software system to create a data base. Concepts, commands, and operational procedures are discussed.

**EVIDENTIAL REASONING IN EXPERT SYSTEMS  
FOR IMAGE ANALYSIS  
February 1985**

Thompson, Terence R.

System Planning Corporation

DACA72-84-C-0006

**Keywords:** Image Analysis, Expert Systems, Evidential Reasoning

This report documents efforts to understand approaches to evidential reasoning of use in application of expert-system or knowledge-based-system techniques to image analysis (IA). There is a growing evidence that these techniques offer significant improvements in image analysis, particularly in the coordinated application of specialized algorithms.

This effort has four principal goals: (1) to clarify the basic issues in evidential reasoning (ER), (2) to provide a common framework for analysis, (3) to structure the ER process for major expert-system tasks in image analysis, and (4) to identify promising directions for further research.

This research was carried out in three major segments. The first segment structured the evidential-reasoning problem in a formal paradigm robust enough to be of practical use in design and construction of expert systems. It then formulated six important theoretical approaches in a parallel fashion in order to identify key assumptions, similarities, and differences.

The second segment applied each of the ER approaches to three important tasks for expert systems in the domain of image analysis. This segment concluded with an assessment of the strengths and weaknesses of each approach.

The third segment addressed promising directions for further research. It reviewed current results and identified important questions bearing on successful application of expert-system technology to image analysis.

## ALTERNATIVE THEORIES OF INFERENCE IN EXPERT SYSTEMS FOR IMAGE ANALYSIS

February 1985

Cohen, Marvin S.  
Watson, Stephen R.  
Barrett, Eamon

Decision Science Consortium, Incorporated

DACA72-84-C-0005

**Keywords:** Expert Systems, Uncertainty, Belief Functions, Fuzzy Sets, Non-Monotonic Logic, Bayesian Statistics, Image Analysis

Reasoning with uncertainty is essential in most expert system applications to image understanding, both for bottom-up analysis of pixel data and for top-down utilization of general knowledge. A variety of alternative approaches have been proposed for inference in expert systems: Bayesian probabilities, belief functions, fuzzy sets, non-monotonic logic, and others. They differ in the concepts they seek to address, in their normative justification, in computational feasibility and input burden, and psychological aptness for the purposes of experts and expert system users.

The present report has two main objectives: (1) to clarify the strengths and weaknesses of various inference mechanisms for expert system applications, and (2) to develop alternative approaches which remedy shortcomings and retain strengths. We develop the top-level design of a new system, the Non-Monotonic Probabilist (NMP), which takes into account the actual practice of expert statisticians in probabilistic reasoning. Probabilistic analysis typically requires extensive judgments regarding interdependencies among hypotheses and data, and regarding the appropriateness of various alternative models. The application of such models to real problems is typically an iterative process, in which the plausibility of the results confirms or disconfirms the validity of judgments and assumptions made in building the model. All these features seem to conflict with the modularity of knowledge representations associated with current expert systems. The Non-Monotonic Probabilist, however, embeds a belief function calculus within a framework of non-monotonic reasoning. Probabilistic statements and rules are regarded as assumptions whose acceptance or use depends on their consistency with other beliefs. Non-monotonic reasoning is itself guided by measures of the credibility of belief function arguments. Fuzzyifying those measures provides for a simple, graded process of control over belief revision. To the extent that assumptions are explicitly tracked and reevaluated, conflict among different sources of evidence or lines of reasoning can lead to improved overall truth of a system of beliefs, and to better analytical results, instead of meaningless statistical compromise.

**DEFENSE MAPPING AGENCY (DMA)  
RASTER-TO-VECTOR ANALYSIS  
November 1984**

Selden, David D.  
Went, Burton H., Jr.  
Kleszczelski, Stan E.

Battelle-Columbus Laboratories

DAAHO1-83-D-A008

**Keywords:** Mapping, Cartography, Plotters, Graphics, Analog-to-Vector Conversion, Raster-to-Vector Conversion, Digital Systems, Benchmark Testing

In this study a comprehensive evaluation was conducted of the analog map to digital cartographic vector data (A/V) conversion process. The evaluation consists of six major subsections: (1) development of an analog-to-vector conversion model which defines an objective framework for evaluation of systems which implement this process; (2) a study of raster-to-vector conversion algorithms and software implementations; (3) a study of current and projected A/V conversion procedures requirements at DMA Hydrographic/Topographic and Aerospace Centers; (4) a study of state-of-the-art automated cartographic data capture systems; (5) development of a standard DMA A/V benchmark testing package and methodology; and (6) recommendations for future research and development.

ETL-0383A

AD-B091 534L

**DEFENSE MAPPING AGENCY (DMA)  
RASTER-TO-VECTOR ANALYSIS-APPENDIX  
November 1984**

Selden, David D.  
Went, Burton H., Jr.  
Kleszczelski, Stan E.

Battelle-Columbus Laboratories

DAAHO1-83-D-A008

This has been published as a special appendix to report number ETL-0383.

**DEFENSE MAPPING AGENCY  
RASTER-TO-VECTOR BENCHMARK TESTING  
December 1984**

Selden, David D.  
Went, Burton H., Jr.

Battelle-Columbus Laboratories

DAAHO1-83-D-A008

**Keywords:** Mapping, Cartography, Benchmark Testing Materials, Benchmark Testing Methods, Scanners, Digitizing Systems, Graphics, Plotters

Battelle's Columbus Laboratories (BCL) conducted raster-to-vector benchmark testing on two cartographic data capture systems at the Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC). A cartographic benchmark testing package and testing methodology, developed during an earlier project, were validated during the testing on DMA production systems. This final report consists of six topical areas: (1) benchmark testing materials and testing methods, (2) benchmark testing results, (3) benchmark testing materials and testing methodology validation, (4) recommendations for benchmark testing of non-DMA cartographic data capture systems, (5) recommendations for future research and development, and (6) observations about in-house system characteristics and operating procedures.

ETL-0385

AD-A153 112

**FURTHER STUDY OF DIGITAL MATCHING  
OF DISSIMILAR IMAGES  
February 1985**

Berenstein, Carlos  
Kanal, Laveen  
Lambird, Barbara

Lavine, David  
Leifker, Daniel  
Olson, Eric

L.N.K. Corporation

DACA76-82-C-0003

**Keywords:** Edge Detection, Filtering, Match Accuracy, Point Feature Matching, Registration

This report reviews the L.N.K. registration algorithm and provides an example. The matching of radar and optical imagery was investigated. Special processing of the radar imagery was found to be required and an edge-preserving local filter was successfully applied. A foundation was begun for transformation reliability estimation through the concept of point pattern spaces, as an alternative preferable to least squares. Pattern spaces for translation, rotation, and point reordering were considered.

**LANDSAT AND DMA ELEVATION STUDY**  
**September 1984**

Faust, N.L.

Georgia Institute of Technology

F-33657-82-G-2083

E-115

**Keywords:** DFAD, DTED, Landsat, MSS, TM, Visual

A study was undertaken to investigate the overlay of Landsat MSS and TM data over DMA elevation data. Two study regions in different physiographic regions were studied. Landsat data were geometrically corrected to overlay the DTED elevation. DFAD data for one study area were decoded and overlaid on Landsat data. Three dimensional perspective images of the integrated data set were developed.

ETL-0387

AD-A152 519

**APPLICATION OF ARTIFICIAL INTELLIGENCE TO  
RADAR IMAGE UNDERSTANDING**  
**February 1985**

Franks, D.T.  
Musselman, J.A.  
Sapp, J.W.

Software A&E, Incorporated

N00014-84-C-0463

**Keywords:** Radar Image Understanding, Image Processing, Artificial Intelligence

This report describes applied research into the application of artificial intelligence (AI) techniques to the problems associated with the extraction of terrain features from synthetic aperture radar (SAR) images. Specific AI techniques have been implemented and analyzed. They have given positive results. A conceptual model for an image-understanding system is described. The model provides the framework for a flexible experimental image-understanding research tool as well as potential for growth to an operational system.

**A NEW LARGE-SCALE, HIGH-RESOLUTION, MULTICOLOR  
SOFTWARE DISPLAY CONCEPT**

**March 1985**

**Logan, Joseph G.**

**Applied Energy Sciences, Incorporated**

**DACW72-84-C-0013**

**Keywords:** Display Technology, Flat Screen Display, Large Screen Display, Multicolor Software Display

Progress in CRT display technology has been limited. Consequently, new technologies are being examined (e.g., solid-state, "flat-panel" displays) that might be applicable for a large-scale, high-resolution, multicolor software display.

In this proposal, a "new" approach to very large screen display technology is suggested, based on the unique piezoelectric properties of stretched polyvinylidene fluoride films. The objective of this Phase I program is to demonstrate that individual picture elements can be developed, yielding the necessary gray-scale range, to form the basis for large-screen display and that these elements can also easily be modified to incorporate full-color display.

This report provides a summary of the activities carried out during the six-month Phase I program to demonstrate that the use of simple bimorph elements to modulate light beams provides a very simple technique for the development of large, flat-screen display systems. The construction of simple prototype display elements to demonstrate the feasibility of the approach is also described. The potential for the development of inexpensive display systems is suggested.

In particular, it is shown that the U.S. Army Engineer Topographic Laboratories' requirement for a large-scale, high-resolution, multicolor software display to proof and display maps and charts can be satisfied using this approach.

**HIGH-SPEED, LARGE-FORMAT FILM WRITER  
METHODOLOGIES AND DESIGN STUDY  
May 1985**

Dunn, S. Thomas

Dunn Technology, Incorporated

DACA76-84-C-0009

**Keywords:** Color Proofing, Electronic Imaging, Electronic Prepress, Film Processing, Film Scanners, Film Writers, Graphic Arts

This report summarizes the results of an in-depth analysis of methodologies and technologies applicable to high-speed film imaging of digital cartographic data files on a large-format film base. It identifies and reports on candidate systems/technologies and recommends a course of action for successful development of a system in the 1985-1990 timeframe.

**HIGH-SPEED, LARGE-FORMAT FILM WRITER  
METHODOLOGIES AND DESIGN STUDY-ANNEX A  
May 1985**

Dunn, S. Thomas

Dunn Technology, Incorporated

DACA76-84-C-0009

**Keywords:** Color Proofing, Electronic Imaging, Electronic Prepress, Film Processing, Film Scanners, Film Writers, Graphic Arts

This annex to ETL-0389 contains proprietary information only.



**SYSTEM ANALYSIS OF THE ENTIRE  
TOPOGRAPHIC SUPPORT SYSTEM  
February 1985**

Gold, Arthur A.  
Goldsmith, C. Thomas  
Sellers, Val E.

DECILOG, Incorporated

DAAK70-82-C-0095

**Keywords:** Topographic Systems, Battlefield Systems, Simulation, System Throughput Efficiency

In 1978, Decilog completed a Computer Simulation Model of the Topographic Support System (TSS) under contract for the Engineer Topographic Laboratories (ETL). As a result of exercising that Model, it was possible to conclude that the TSS, as configured by an interagency Integrated Equipment Evaluation Team, was capable of producing the required Products and Services in a manner which was then considered timely.

With the passage of time, however, there were changes in the TSS design and environment. Furthermore, the 1978 model was restricted to a particular scenario. For these reasons, it was desirable to revise the 1978 model to both update it and remove the restrictions.

In addition, it was desirable to teach a group of government employees how to use the simulation. In this way it could be "handed over" to the Government, which would then have a System Analysis tool.

The major objectives of this effort, then, were to:

- Revise the Simulation Model to simplify input and add additional features to enhance flexibility.
- Install ETLSIM on the ETL Cyber 170 and train government personnel in its use and in the analysis of the simulations.
- Perform a continuing analysis of classified inputs to assure that ETLSIM could be utilized to assess their impact on field army topographic units.

These objectives have been met.

The following modifications to the 1978 model were completed:

- The model was modified to conform with changes made by MERADCOM for the fabrication contract.
- The Product Lists were revised.

As these changes were added to the code, the simulation program became more and more complicated. Since a prime objective was to have government personnel learn how to use the system, this complication was especially bad. Therefore, it was decided to scrap the 1978 simulation and completely rewrite the code. A product of this rewriting is a program in which the analyst specifies the characteristics of the system which is to be simulated. The program then "builds" the system, simulates its operation and produces a statistical report. This capability, ETLSIM, has the following features:

- The Direct Support vehicle was simulated rather than ignored.
- The product list is easily modified by the analyst.
- Alternate paths through production steps have been provided.
- It is now easy for the analyst to "install" new equipments in the field topographic units for analysis.
- The capability of having equipments "fail" and "be repaired" as a function of Mean Time Between Failures and Mean Time to Repair has been added.
- The time unit and duration of the simulated system are specified by the analyst.

ETLSIM has been delivered to the Government. It was installed on and tested at the MERADCOM Computing Center and at Cyber 170 at the ETL Computing Center. A four-week training course was given with extensive course materials provided. Those personnel who attended all, or nearly all, of the sessions were able to use all of the features of the model after the training.

A continuing analysis of classified inputs was conducted during the contract to ensure that ETLSIM could be utilized to assess their impact on field army topographic units.

**COMPUTER-ASSISTED LIKELY MINESITE PREDICTION  
MODEL AND ESTIMATED ELECTROMAGNETIC  
AND THERMAL SOIL PROPERTIES  
May 1985**

Bidwell, Bernard L.  
Armstrong, Mary

IIT Research Institute

DACA72-84-C-0007

**Keywords:** Computer-assisted, Minefield, Prediction, Synthesis, Terrain Factor

It is essential that a commander have as much accurate information as possible to plan and execute tactics. The location and the detection of the most likely minesites are most valuable in aiding the commander towards this goal. The "most likely minesites" are areas in which minefields will most probably be placed. These sites are determined by terrain, mine doctrine, and military objectives. Terrain features that affect the placement of mines are soil, slope, and vegetation as well as waterways, roads, bridges, etc. Some very important parameters of the soil feature are near-surface moisture content and such electromagnetic parameters as attenuation, permittivity, and thermal capacity. These parameters, which are dependent on soil type, climate, time of year, and location, are critical in selecting the proper sensors for minefield detection and identifying the most likely minefield areas. This model provides such information in both graphics and printed form.

ETL-0393

AD-A164 305

**DIGITAL TERRAIN ELEVATION MODEL ANALYSIS  
July 1985**

Loon, Joseph C.  
Patias, Petros G.

The Ohio State University Research Foundation

DAAG29-81-D-0100

**Keywords:** Cartography, Contour to Grid Algorithms, Digital Elevation Model, Digital Terrain Elevation Data, Fourier Series, Surface Interpolation, Synthetic Surface

An effort to develop techniques to evaluate contour-to-grid interpolation algorithms. The use of synthetic surfaces as a tool is explored. A set of synthetic surfaces is generated using Fourier Series to represent terrain with different degrees of ruggedness; each surface represented by an equation of the form:  $Z=F(X,Y)$ . The results of a contour-to-grid interpolation can then be evaluated by comparison with the "true elevations," the elevations calculated from the synthetic surfaces.

**SOFTWARE CONVERSION OF STANDARD LINEAR FORMAT (SLF)  
TO STANDARD INTERCHANGE FORMAT (SIF)**

**July 1985**

Sands, Kathryn J.

Headlee, Kim D.

Measurement Concept Corporation

**DAAK70-83-C-0174**

**Keywords:** Defense Mapping Agency, Standard Linear Format, Intergraph Corporation, Standard Interface Format, Graphic Symbolization

Software accepts a digital cartographic data set in DMA Standard Linear Format as input and generates graphics and attribute data base information in Intergraph Corporation Standard Interchange Format. Cartographic feature information is examined to derive graphic symbolization characteristics. Validation of inputs ensures the quality of the output. Additional software provides the capability to convert from Intergraph Standard Interchange Format to DMA Standard Linear Format.

ETL-0395

AD-A160 607

**BIBLIOGRAPHY OF IN-HOUSE AND  
CONTRACT REPORTS, SUPPLEMENT 13**

**May 1985**

Books, E. James

Fox, Margaret F.

Holmes, Alice L.

Author and title indexes are provided for the ETL "Bibliographies of In-House and Contract Reports." The indexes are designed to be used in conjunction with the 13 published bibliographies and refer to them by year and page: AD-877 653L(1970); AD-890 066L(1971); AD-905 548L(1972); AD-B005 275L(1975); AD-B010 642L(1976); AD-B019 966L(1977); AD-A055 468(1978); AD-A068 744(1979); AD-A084 111(1980); AD-A099 803(1981); AD-A113 006(1982); AD-A128 400(1983); AD-A141 778(1984).

The indexes were prepared by the staff of the Scientific and Technical Information Center.

**THIRD-ORDER CO-OCCURRENCE TEXTURE ANALYSIS  
APPLIED TO SAMPLES OF HIGH RESOLUTION  
SYNTHETIC APERTURE RADAR IMAGERY**  
August 1985

Hevenor, Richard A.

**Keywords:** Texture Analysis, Pattern Recognition, Radar Imagery

A third-order co-occurrence texture analysis technique was applied to samples of synthetic aperture radar imagery. This technique was applied to four classes of terrain features on selected samples of radar imagery. The four classes considered were forests, cities, agricultural fields, and water. A feature vector was computed from samples of each class. A linear feature selection technique was applied for dimensionality reduction, and a pseudo-inverse classifier was developed. This classifier was applied to the original training samples as well as to other samples from the same imagery.

**DEVELOPMENT OF ELECTRONIC CONTROL OF A  
SUPERCONDUCTING GRAVITY GRADIOMETER**  
September 1985

Paik, Ho Jung  
Richard, J.-P.

University of Maryland

DACA72-84-C-0004

**Keywords:** Feedback Control Network, Gravity Gradiometer, Magnetic Switch, Shielded Transformer, Spring-mass System, SQUID, Superconductivity, Three-axis Gradiometer, Vacuum Oven

This report discusses the development of a three-axis superconducting gravity gradiometer and a six-axis superconducting accelerometer for geological and navigational applications.

**ELECTRONIC FEEDBACK CONTROL OF  
MASS-SPRING SYSTEMS**  
September 1985

Kong, Qin

University of Maryland

DACA72-84-C-0004

**Keywords:** Ground Motion Isolation, Josephson Junction, Mass-spring System, SQUID Amplifier, Wide-band Accelerometer

This thesis develops an electronic system for the control of motion of different types of active springs, thus improving the performance of mass-spring systems. A mathematical analysis is carried out for various types of active springs. Also, this thesis discusses future design for improving the performance of these electronic circuits to achieve even better performance of mass-spring systems.

ETL-0399

AD-A159 364

**EXTENDED AREA EXIT PUPIL VIEWER**  
August 1985

Radl, Bruce

EIKONIX Corporation

DACA76-83-C-0008

**Keywords:** Exit Pupil, Head Moving Parallax, Human Factors Engineering, Illumination, Image Diffuser, Image Quality, Lens Vignetting, Magnification, Resolution, Toroidal Field Mirror

This report describes the process of designing and building a prototype Extended Area Exit Pupil viewer. This system will enable comfortable viewing of a projected stereo image. It works by enlarging the microscope's exit pupil, thus allowing increased head movement while maintaining stereo separation of the images.

**NOISE REMOVAL ON RADAR IMAGERY  
USING LOCAL GRADIENT AND STATISTICS**

**September 1985**

**Kim, Jungwhan  
Haralick, Robert M.**

**Mnemonics, Incorporated**

**DACA76-84-C-0003**

**Keywords:** Directional Gradient Masks, Image Blurring, Multiplicative Noise, Noise-removal Filters, Noise Variance

This report shows that the noise-removal algorithm using local gradient and statistics is most favorable to filter a noisy radar image without contrast loss. This report includes the summary of this algorithm with a suggestion of a practical method of estimating a local noise variance. Various noise-removal algorithms are compared with this algorithm based on a visual examination of their filtering results on a set of radar images. The final results of noise removal of the images are displayed along with the originals in the last section. A set of twenty-eight SAR (synthetic aperture radar) images, of size 512x512 pixels, was used for experimentation.

**ROAD DETECTION ON RADAR IMAGERY**

**September 1985**

**Kim, Jungwhan J.  
Haralick, Robert M.**

**Mnemonics, Incorporated**

**DACA76-84-C-0003**

**Keywords:** Linear Features, Radar Imagery, Remote Sensing, Road Network Detection

Detecting a road network on radar imagery is becoming a new area in remote sensing. This report is an attempt to build a facet-based road network detection procedure for radar imagery. This procedure includes the line detection part and the road detection and connection part. The first part analytically detects linear features using a facet valley-finding technique which looks for the first directional derivative zero-crossing of a bicubic facet model. The second part statistically screens the linear features on a component-by-component base and then optimally connects the screened linear features using a dynamic programming algorithm.

**DISCRIMINATION OF WATER FROM SHADOW REGIONS ON  
RADAR IMAGERY USING COMPUTER VISION TECHNIQUES**

September 1985

Qian, Jianzhong  
Haralick, Robert M.

Mnemonics, Incorporated

DACA76-84-C-0003

**Keywords:** MTA Filter, Noise Removal, Radar Interpretation, SAR Imagery, Scene Analysis, Texture Preserving

Unlike MSS LANDSAT imagery and other photography, the specific characteristics of the intensity of water and shadow in SAR imagery make the task of discriminating between them extremely difficult. In this report, we analyze the mechanism of reflectivity of water and shadow on radar imagery and describe a scene-analysis system which consists of a texture-preserving, noise-removal procedure as the preprocessing step, a probabilistic relaxation algorithm to do the low-level labeling, and a spatial reasoning procedure based on a relational model to perform the high-level interpretation. The experimental results obtained from the SAR images are presented to illustrate the performance of this system.

ETL-0405

AD-A161 154

**LINEAR FEATURE EXTRACTION FROM RADAR IMAGERY**

September 1985

Lawton, Daryl T.                      Conner, Gary D.  
Glicksman, Jay                      Drazovich, Robert J.

Advanced Information &amp; Decision Systems

DACW72-84-C-0014

**Keywords:** Artificial Intelligence, Image Understanding, Knowledge-based System, Expert System, SAR Aerial Image Interpretation

This report summarizes a feasibility study performed by AI&DS to determine the requirements for the extraction of linear features such as roads, rivers, and environmental region boundaries from SAR aerial imagery. The effort has involved determining effective processes for extracting such features by algorithm surveys, hand processing sample imagery, and algorithm implementation. This work has provided the necessary basis for the implementation of an intelligent, automated system in Phase II of this research. We have designed a general vision system for linear feature extraction which can be generalized to a wide range of SAR (and other sensor) objects, and begun developments of the components of such a system.



ETL-0406

AD-A160 586

**IMAGE PROCESSING FOR VISUAL NAVIGATION  
OF ROADWAYS  
September 1985**

LeMoigne, Jacqueline  
Waxman, Allen M.

Srinivasan, Babu  
Pietikainen, Matti

University of Maryland

DACA76-84-C-0004

**Keywords:** Image Processing, Computer Vision, Road Following, Linear Feature Extraction, Autonomous Navigation, Region-based Segmentation

The Computer Vision Laboratory at the University of Maryland has developed several image processing algorithms for use by an autonomous land vehicle in order to navigate roadways. This report describes one module of this system, the Image Processing module, which extracts 2-D symbolics from the imagery to be analyzed in the world domain.

ETL-0407

AD-A160 946

**ROAD BOUNDARY DETECTION FOR AUTONOMOUS  
VEHICLE NAVIGATION  
September 1985**

Davis, Larry S.  
Kushner, Todd

University of Maryland

DACA76-84-C-0004

**Keywords:** Image Processing, Computer Vision, Road Following, Autonomous Navigation, Sobel Edge Detector

The Computer Vision Laboratory at the University of Maryland has been developing a computer vision system for autonomous ground navigation of roads and road networks. This report describes the image processing component of that vision system and its implementation on a VICOM image processing system.

**A VISUAL NAVIGATION SYSTEM FOR  
AUTONOMOUS LAND VEHICLES**

October 1985

Waxman, Allen M.  
LeMoigne, Jacqueline  
Davis, Larry S.

Liang, Eli  
Siddalingaiah, Tharakesh

University of Maryland

DACA76-84-C-0004

**Keywords:** Computer Vision, Image Processing, Autonomous Navigation, Road Following, Rule-based Reasoning

The Computer Vision Laboratory at the University of Maryland has developed a modular system architecture to support visual navigation by an autonomous land vehicle. The system consists of vision modules performing image processing, 3-D shape recovery, and rule-based reasoning, as well as modules for planning, navigating, and piloting.

ETL-0409

AD-B097 176L

**MECHANIZATION DESIGN, PERFORMANCE SIMULATIONS,  
AND COST TRADE-OFFS OF HYBRID INS/GPS/PLRS  
POSITIONING AND ORIENTATION SYSTEMS**

October 1985

Bose, Sam C.  
Kouba, James T.  
Sobek, David A.

Applied Science Analytics, Incorporated

DACW72-84-C-0005

**Keywords:** Navigation Error Modeling, Global Positioning System, Position Location Reporting System, Hybrid Inertial Systems, System Performance Simulations, Cost/Performance Trade-Offs, Kalman Filter Mechanizations, Positioning and Orientation Systems

This report documents detailed Kalman filter mechanization designs, computer simulations of system performance, and cost trade-off analyses of several hybrid ground-based positioning and orientation systems, employing externally referenced and dead-reckoning

systems. The externally referenced systems include the Global Positioning System (GPS), and the Position Location Reporting System (PLRS). The dead-reckoning systems considered consist of complete Inertial Navigation Systems (INS), comprising three gyros and three accelerometers, augmented with an odometer and a barometric altimeter. Both gimbaled and strapdown INS technology is investigated. The inertial sensors range in quality from high, to medium, to low, corresponding approximately to a CEP rate of 1, 10, and 100 nm/hr open loop (free-inertial) performance, respectively. The relative merits of the various hybrid systems were compared based on performance measures established on system velocity, azimuth, attitude, and position error. Performance degradation due to system jamming is also included. Results show that the most promising candidates for further analysis and fabrication appear to be low and medium accuracy strapdown inertial systems in combination with GPS.

ETL-0410

AD-A164 325

**AUTOMATIC FEATURE EXTRACTION/ALGORITHM TESTING**  
**November 1985**

Ferris, Ned A.

Autometric, Incorporated

DACA72-84-C-0008

**Keywords:** Clustering, Digital Image Processing, Edge Operator, Feature Extraction, Segmentation, Target Detection, Texture

Feature extraction results using an Improved Texture Clustering Algorithm were compared to photo interpreters' manual segmentation/classification results. The clustering algorithm segments digital images via texture and edge attributes. The probability of detecting a target or feature is increased if the number of segments is reduced; therefore, the algorithm merges segments via edge thresholds. Evaluation showed general agreement, but the edge attributes would apply more to target detection than to feature classification.

ETL-0411

AD-A163 674

**APPLICATION OF HIERARCHICAL DATA STRUCTURES  
TO GEOGRAPHICAL INFORMATION SYSTEMS  
PHASE IV  
December 1985**

Samet, Hanan  
Rosenfeld, Azriel

University of Maryland

DAAK70-81-C-0059

**Keywords:** Quadtrees, Hierarchical Data Structures, Geographical Information Systems, Linear Edge Quadtree, PM Quadtree, PMR Quadtree, Edge Quadtree, MX Quadtree

This document is a report on Phase IV of an investigation of the application of hierarchical data structures to geographical information systems. It deals primarily with developing new structures for storing linear feature data. The attribute attachment package was extended to point and linear feature data.

ETL-0412

AD-A163 201

**BLUE LASER  
December 1985**

Griffin, Gordon R.

Xerox Special Information Systems

DACW72-84-C-0016

**Keywords:** Hollow Cathode Laser, Blue Laser, Low Noise Laser, He-Cd Laser, Metal Vapor Laser, Gas Laser

This has been a development program to design a low noise, moderate power, blue, hollow cathode laser used for imaging on photoconductors for on-demand color printing. Descriptions of the construction, processing, and testing of experimental unit are presented with recommendations for design improvements.

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**Robertson, Kenneth D.** "The Potential of the NAVSTAR Global Positioning System for the Corps of Engineers/Civil Works." *U.S. Army Corps of Engineers Surveying Conference*, Jacksonville, Florida, 4–8 February 1985. AD–A154 913

**Rose, Eugene J.; Bose, Sam C.; Kouba, James T.; and Sobek, David (Applied Science Analytics, Incorporated).** "A Cost/Performance Analysis of Hybrid Inertial/Externally Referenced Positioning/Orientation Systems." *Third International Symposium on Inertial Technology for Surveying and Geodesy*, Banff, Canada, 16–20 September 1985. AD–A167 685

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**Wilkinson, Andrew.** "Optical Disc Technology for Mapping." *American Society of Photogrammetry—American Congress on Surveying and Mapping (ASP–ACSM) Convention*, Washington, D.C., 10–15 March 1985. AD–A154 989

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Inertial Positioning System Test Data Summary Report	ETL-0028 1975
Inertial Survey Applications to Civil Works	ETL-0309 1983

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Inertial Survey Equipment (GEISHA)	AD-814 051	1963
Inferential Techniques for Soil Depth	ETL-0036	1975
Determinations: Part I, <i>Coleogyne ramossissima</i>		
Torr. (Black-Brush)		
Inferential Techniques for Soil Depth	ETL-0176	1979
Determinations, PART II: <i>Artemisia filifolia</i>		
Torr. (Sand Sagebrush)		
Influence of Atmospheric Refraction on Directions	RN-10	1963
Measured to and from a Satellite		
Instrument for Measuring Absolute Acceleration	RN-17	1966
of Gravity		
Instrument to Measure the Tilt of Large Structures, An	ETL-0313	1983
Instrumentation for Color Aerial Photography	ETL-RN-70-1	1970
Intelligent Advisors for Cross-Country	ETL-0365	1984
Route Planning		
Interactive Digital Correlation Techniques for	ETL-0272	1981
Automatic Compilation of Elevation Data		
Interactive Digital Image Processing for Terrain	ETL-0241	1980
Data Extraction		
Interactive Digital Image Processing for Terrain	ETL-0277	1981
Data Extraction, Phase 2		
Interactive Digital Image Processing for Terrain	ETL-0294	1982
Data Extraction, Phase 3		
Interactive Digital Image Processing for Terrain	ETL-0348	1983
Data Extraction, Phase 4		
Interactive Digital Image Processing for Terrain	ETL-0374	1984
Data Extraction, Phase 5		
Interactive Digital Image Processing	ETL-0172	1978
Investigation		
Interactive Digital Image Processing	ETL-0221	1980
Investigation, Phase II		
Interactive Image Analysis System Design	ETL-0312	1982
Interactive Knowledge-Based Cartographic	ETL-0273	1981
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Interagency Energy and Environmental Survey		1977
Interferometer Data Reduction Study	AD-503 143L	1969
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Interpolation of Deflections from Horizontal	AD-672 490	1967
Gravity Gradients		

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Interpretation of Radar Imagery for Terrain Analysis in Tropical Environments	1968
Inverse Scattering Applications in Determining Terrain Feature Parameters	ETL-0279 1981
Investigation and Evaluation of Planigon Lens Distortion Characteristics	1472-TR 1957
Investigation, Experiments, and Study of Electron Beam Recorder (EBR) Techniques for Map Production	ETL-CR-73-15 1973
Investigation of Bjerhammar's New Gravity Reduction Method	AD-460 404 1964
Investigation of Cartographic Pressplate Recording from Digital Data	ETL-0043 1976
Investigation of Continuous Photoconductive Layer Arrays	ETL-0011 1975
Investigation of Discrete Function Technology for Topographic Sciences	ETL-0162 1978
Investigation of Electro-Acoustic Technology for Topographic Application	ETL-0160 1978
Investigation of Extrema in Digital Images for Texture Analysis	ETL-0210 1979
Investigation of Fusion and Fixation Disparity Limits for Photogrammetry	AD-625 217 1965
Investigation of Linear Transformations for Automatic Cartographic Analysis	ETL-0181 1979
Investigation of Multiband Photographic Techniques, Vol. I	AD-479 300L 1965
Investigation of Multiband Photographic Techniques, Vol. III	1965
Investigation of Photographic Mapping Detail and Data Encoding	AD-286 715 1962
Investigation of Techniques to Generate Contours from Stereo-Pairs	ETL-0029 1975
Investigation of the Application of "Array Algebra" to Terrain Modeling	ETL-0141 1978
Investigation of the Electronic Distance Measuring Equipment Electrotape	AD-460 401L 1964
Investigation of the Geometrical Quality of the Relative and Absolute Orientation Procedures and the Final Results of the Photogrammetric Procedure	RN-6 1962

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Investigations into the Problems of Relative Orientation in Stereo Aerial Photogrammetry	AD-452 686L	1964
Investigations of Basic Geometric Quality of Aerial Photographs and Some Related Problems	RN-4	1962
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Investigations Related to the Establishment of a World Geodetic System	AD-697 163	1969
Joint Analyses in Glen Canyon National Recreational Area	ETL-0073	1976
Kalman Filtering and Smoothing in Fotonap for Orbit Determination using GPS Measurements	ETL-0161	1978
KANDIDATS	ETL-CR-71-3	1971
Knowledge-Based Images Analysis	ETL-0258	1981
KT2 Gyro-theodolite (Otto Fennel GMBH & Co)	57-TR	1970
Land Cover Classification from LANDSAT Data: Phase III of a Joint OCE/NASA Demonstration	ETL-0175	1979
LANDSAT D: Corps of Engineers Interface with Advanced NASA Ground Systems Study	ETL-0151	1978
Light, Target for Ranging Pole	1402-TR	1955
Lightweight North-Seeking Gyro Azimuth Surveying Instrument, Model IING531A	AD-486 317	1965
Lightweight North-Seeking Gyro Azimuth Surveying Instrument, Model IING531B	AD-844 011L	1968
L.N.K. Software Systems for Transferring, Merging, and Displaying DFAD/DTED Data on AMS/CAPIR	ETL-0318	1983
Long Range Survey System	AD-356 441L	1964
Long Range Surveying System	AD-328 203	1960
Low Cost Gyrocompass	ETL-355	1984
Low Light Level Photography	32-TR	1966
Manual and Automated Line Generalization and Feature Displacement	ETL-0359	1984
Manual for Maintenance and Operation of the MB-1 Multiband Aerial Camera	ETL-0040	1976
Map Coating Concept Studies	AD-679 215	1968
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MAPCON Design Study	AD-854 619L	1967
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Materials Research for Holographic Recording (Report No. 1, Multiple Image Storage of Continuous Tone Data in Volume Holograms)	ETL-0088 1976
Materials Research for Holographic Recording (Report No. 2, Bleaching Methods for Photographically Recorded Holograms)	ETL-0156 1978
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Mathematical Analysis of a Technique for the Calibration of a Synthetic Aperture Radar	43-TR 1968
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Mathematics of Geodetic SECOR Data Processing	1964
Matrix Evaluation of Remote Sensor Capabilities for Military Geographic Information (MGI)	ETL-TR-72-6 1972
MATS Performance with the SECOR System	
MATS Transponder	1966
Measurement of the Change in the Deflection of the Vertical with a Schuler-Tuned North-Slaved Inertial System	ETL-0138 1977
Measurement Techniques of Electrical Parameters of Surface Materials in the X-Band Region	ETL-0304 1982
Mensuration and Reduction Accuracy and Precision Standard Applicable to an Integrated World-Wide Topographic System	58-TR 1970
Methodological Preliminaries to the Development of an Expert System for Aerial Photo Interpretation	ETL-0342 1984
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Methods and Results of Remote Barometric Altimetry and Views on the Estimation of Meteorological Field Variable	ETL-RN-73-3 1973
Methods for Calculating Atmospheric Refraction and Its Perturbation	ETL-0299 1982
Micromap Camera for Display Systems	ETL-ETR-71-5 1971
Microreduction and Enlargement of Graphic Information Study (MEGIS)	ETL-0063 1977

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Microwave Pointing Variations and Angle Measurements	26-TR 1966
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Military Potential Test of Selected Items of Hydrologic Survey Equipment	AD-890 746 1971
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Miniaturized Gyrocompass	ETL-0289 1982
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Mini Raster-to-Vector Conversion	ETL-0269 1981
Mod II Power Supply for Army Artillery Inertial Survey System (GEISHA)	AD-814 067 1963
Modeling and Contouring Irregular Surfaces Subject to Constraints	ETL-CR-74-19 1975
Modes of Satellite Triangulation Adjustment, Vol. I	AD-633 863 1966
Modes of Satellite Triangulation Adjustment, Vol. II	AD-633 864 1966
Modification of a Cartographic Mapping Camera from Type T-11 to Type KC-4B (with Automatic Exposure Control)	ETL-TR-71-1 1971
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Morphometry of Landforms: Quantification of Slope Gradients in Glaciated Terrain	ETL-RN-72-3 1972
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Multi-Image Correlation System Study for MGI	AD-841 079 1968
Multi-Image Correlation Systems Study, Quantitative Evaluation of Electronic Multi-Image Processor	1969

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Multi-Image Pattern Recognition: Ideas and Results	AD-863 596
Multiparametric Figures of Equilibrium: Curvature of the Plumb Line	AD-603 073 1964
Multiparametric Theory of Spheroidal Equilibrium Figures and the Normal Spheroids of Earth and Moon	1966
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Multisensor Approaches for Determining Deflections of the Vertical	ETL-0314 1983
Multisensor Study of Plant Communities at Horsefly Mountain, Oregon	AD-698 098 1969
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Multispectral Target Signatures	ETL-0165 1978
MUSAT IV	ETL-CR-70-6 1970
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Near-Real-Time Application of Digital Terrain Data in a Minicomputer Environment	ETL-0142 1978
Near-Surface Bathymetry System, Report No. 11 in the ETL Series on Remote Sensing	ETL-0163 1978
New Analyses and Methods Leading to Improved Target Acquisition Requirements Involving Systems, Geodetic and Reentry Errors, and Increased Weapons Effectiveness for Conventional Weapons (Part I)	RN-35 1970
New Analyses and Methods Leading to Improved Target Acquisition Requirements Involving Systems, Geodetic and Reentry Errors, and Increased Weapons Effectiveness for Conventional Weapons (Part II)	ETL-RN-70-3 1970
New Analytical Methods for Simulation/Estimation of Asymmetric Satellite Dynamics	ETL-CR-73-21 1973
New Formulas Useful When Changing Ellipsoidal Parameters or Orientation	RN-2 1962
New Insights and Results Regarding L.F. Richardson's Turbulence Criterion	ETL-RN-72-2 1972
New Method for Determining Azimuth and Latitude Independent of Time and Zenith Distance	RN-17 1966

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Occurrence of Ice in the Form of Glaze, Rime, and Hoar-Frost with Respect to the Operation and Storage of V/STOL Aircraft	ETL-SR-73-1 1973
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Optical Power Spectrum Analysis (OPSA) (Report No. 1 Recording Optical Spectrum Analyzer System Hardware)	ETL-TR-74-11 1975
Optical Theodolite Readout	AD-821 660L 1967
Optimized Digital Automatic Map Compilation System	
1st Interim Report	AD-412 798 1963
2nd Interim Report	AD-422 227 1963
3rd Interim Report	AD-432 243 1963
4th Interim Report	AD-600 117 1964
Optimized Method for the Derivation of the Deflection of the Vertical from RGSS Data	ETL-0122 1977
Optimized Post-Mission Determination of the Deflection of the Vertical Using RGSS Data	ETL-0164 1978
Orthographic Radar Restitutor Engineer Design Test	ETL-ETR-74-6 1974
Orthophoto Viewer and Transfer Device	1965
Parallel Optical Processing to Convert Elevation Data to Slope Maps. Phase I: Theoretical Analysis	ETL-RN-74-9 1974
Parallel Optical Processing to Convert Elevation Data to Slope Maps. Phase II: Practical Considerations	ETL-RN-74-12 1975
Parallel Profile Plots for Visual Terrain Display	ETL-0115 1977
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Performance Evaluation of the Position and Azimuth Determining System (PADS) with an Improved Vertical Accelerometer	ETL-0166 1978



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Phoenix Laser and Terrain Profile Test	1966
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Photogrammetric Applications to Field Artillery	56-TR 1970
Photogrammetric Aspects of the Heterodyne Optical Correlator	ETL-0095 1976
Photogrammetric Flash Triangulation for Corps of Engineers Field Use	
1st Interim Report	1960
2nd Interim Report	AD-265 036 1961
3rd Interim Report	AD-271 438 1961
Final Report	AD-271 439 1961
Photographic Visibility of Light Images on Aerial Film	1966
Photomap Reproduction System	1965
Pilot Program of Lunar Photography for Precise Selenodesy	AD-452 237 1964
Plastic-Scribing Color Separation for Military Cartography	1485-TR 1957
Platform Orientation System Test Program	ETL-0100 1976
Point Light Source Contact Printer Photographic Technology Series	ETL-0084 1976
Position and Azimuth Determining System (PADS)	ETL-ETR-74-1 1974
Position and Azimuth Determining System (PADS) Helicopter Study	ETL-0009 1975
Position and Surveying System (PASS)	ETL-CR-73-11 1973
Possibility of Adapting a Land Navigation System to Perform Artillery Survey	ETL-0078 1976
Post-Mission Smoothing and Analysis of the Measurements of the Change in the Deflection of the Vertical Obtained by the Rapid Geodetic Survey System (RGSS) at the White Sands Test Range	ETL-0065 1976
Potential of Thermal IR Imagery for Supplemental Map Information in Snow-Covered Areas	ETL-0059 1976
Potential Sand and Dust Source Areas	ETL-SR-72-1 1972
Practical Field Accuracy Limits for a Wild T-2 Theodolite	30-TR 1966

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Practical Second-Order Theory for the Disturbance Potential and Deflections of the Vertical, Including an Analysis of the Limitations of the Molodensky/Brovar Series and Downward Continuation of Gravity	ETL-RN-71-1	1971
Practical Tests of the Theoretical Accuracy of Aerial Triangulation	RN-1	1962
Precise Photogrammetric Orientation and Data Determination of HIRAN Mapping System AN/APQ 73	AD-238 857	1960
Precision Enlarging Printer (4X)	27-TR	1966
Precision 2.0X Enlarging Printer	55-TR	1970
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Precision STARAN Correlator	ETL-0133	1977
Predesign Data for the Radar Stereo Equipment Program	AD-701-169	1969
Preliminary Image Data Extraction Experiments with the Phase I, Automated Image Data Extraction System - I	ETL-RN-74-7	1974
Preliminary Radar Feature Extraction and Recognition Using Texture Measurement	ETL-0315	1983
Preliminary Reliability Prediction - MATS		1965
Preliminary Study into the Principles of Continuous Tone Electrophotography	AD-401 863	1962
Preproduction Model Cartographic EBR System	ETL-0246	1980
Proceedings of the International Symposium Figure of the Earth and Refraction	AD-825 792	1967
Product Improvement Test Report of Astronomic Surveying Equipment	28-TR	1966
Program and Test Procedures to Determine the Geocentric Coordinates and Orbital Parameters of an Unidentified Satellite	AD-617 698	1965
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Programmer for Army Artillery Inertial Survey System (GEISHA)	AD-814 065	1963
Project SAND - Availability of Construction Materials in the Mekong Delta	Tech Memo 156-1	1968
Project SAND (Phase III) Analysis of Remote Sensor Imagery of Selected Areas in the Mississippi Delta	ETL-TR-71-3	1971

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Project THEMIS: A Center for Remote Sensing		
Study Plan	AD-690 361	1968
Progress Report	AD-847 276	1968
Interim Report	AD-683 584	1968
Progress Report	AD-853 884	1969
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5th Semi-annual Report	AD-869 511	1970
6th Semi-annual Report	AD-879 981L	1970
7th Semi-annual Report (ETL-CR-71-7)	AD-726 966	1971
8th Semi-annual Report (ETL-CR-71-21)	AD-735 752	1971
Final Report (ETL-CR-74-10)	AD-A003 266	1974
Propagation of Very Short Radio Waves Through the Ionosphere and the Investigation of Inospheric Models	ETL-RN-74-1	1973
Proposed Stereophotogrammetric System for Topographic Mapping from Photography Taken at Altitudes up to 100,000 Feet	1518-TR	1958
Prototype Automatic Mosaicking System	17-TR	1963
Prototype Electrostatic Image Reproducer	ETL-0035	1973
Prototype Image Spectrum Analyzer (PISA) for Cartographic Feature Extraction	ETL-0204	1979
Prototype Lithographic Enlarging Projection Platemaker	ETL-ETR-72-4	1972
Prototype Stereomat System	4-TR	1962
Quantitative Geography: Achievements and Prospects	ETL-CR-71-12	1971
RACOMS Cartographic Module	ETL-ETR-70-3	1970
RACOMS Compilation Module I	ETL-ETR-70-1	1970
RACOMS Data Processing Module	ETL-ETR-70-4	1970
RACOMS Image Processing Module I	47-TR	1969
RACOMS Image Processing Module II	ETL-ETR-70-2	1970
RACOMS Map Revision Module	ETL-ETR-70-5	1970
RACOMS Operations Module	44-TR	1969
RACOMS Pass Point Marking and Measuring Instrument	53-TR	1970
RACOMS Reproduction Module	ETL-ETR-71-1	1971
Radar Backscatter from a Vegetated Terrain: A Discrete Scattering Approach	ETL-0159	1979
Radar Bridge Patterns Extraction and Recognition	ETL-0323	1983
Radar Image Simulation of Seasonally Dependent Reference Scenes	ETL-0188	1979
Radar Image Simulation Project	ETL-0098	1976

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Radar Image Simulation: Validation of the Point Scattering Model, Volume I	ETL-0117	1977
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Radar Mapping Beacon Analysis	ETL-CR-73-22	1973
Radar Mapping Test Ranges		1959
Radar Network Adjustment		1962
Radar Presentation Restitutor		1956
Radar Sketching Device	20-TR	1965
Radar Stereo Equipment Program	AD-732	875 1971
Radar, Thermal Infrared, and Panchromatic Image Collection and Analysis	ETL-0249	1980
Radiative Transfer in One-Dimensional Discretely Stratified Media	ETL-0236	1980
RADOT Code for the Tracking of Radar Incident on Trees	ETL-0147	1978
RADOT Code System to Calculate the Radar Return from a Forested Area	ETL-0206	1979
Rainfall Intensities in the Conterminous United States and Hawaii (Supplement 1 to ETL-SR-72-5: Distribution of Mean Monthly Precipitation and Rainfall Intensities)	ETL-SR-74-3	1973
Rapid Cartographic Processing System Study	AD-454	086L 1964
Rapid Combat Mapping System Evaluation	ETL-ETR-70-8	1970
Rapid Geodetic Survey System	ETL-0074	1976
Rapid Geodetic Survey System (RGSS) Deflection of the Vertical and Gravity Anomaly Tests at White Sands Missile Range, 1980	ETL-0308	1982
Rapid Gravity Survey System Aided with Supplemental Gravimetric Data	ETL-0113	1977
RC-135A/USQ-28 Category II Test (The Photo- graphic Resolution Capabilities of the KS-78A Camera Subsystem)	TM-69-1	1969
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Recognition of Handprinted Symbols for Computer- Aided Mapping	ETL-CR-71-27	1971
Recording and Scanning Advances in Cartographic EBR Systems	ETL-0265	1981
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Reduction Procedures for Absolute Direction and Geodetic Azimuths from Optical Observations of Satellites	RN-14 1965
Reflection and Identification Studies Applied to Terrain Imaging Radar	ETL-0331 1983
Refraction in Selected Model Atmospheres	AD-404 465 1964
Registration of a LANDSAT Image to a DTM-An Error Analysis	ETL-0350 1984
Relation Between the Spectrum of Surface Slopes and the Spectrum of Surface Elevations and its Usefulness in the Theory of Electromagnetic Wave Scattering from Rough Surfaces	ETL-RN-70-2 1970
Relational Data Base Management Study	ETL-0136 1978
Remote Sensor Image Capabilities for Acquisition of Terrain Information	ETL-0054 1976
Remote Sensor Imagery Analysis for Location of Construction Materials in the Mekong Delta-Project SAND (Phase II)	52-TR 1970
Replacement of Photographic Imagery Equipment (RPIE)	ETL-0038 1976
Report on Atmospheric Obstructions to Visibility: Volume I - Study Results	ETL-0169 1979
Report on Atmospheric Obstructions to Visibility: Volume II - Results of Literature Search	ETL-0170 1979
Research and Design of a PROM Coherent Optical Processor	ETL-0219 1980
Research and Development Acceptance Test Report Surveying Instrument: Azimuth, Gyro, Lightweight (Lear Siegler Inc. Models)	23-TR 1965
Research and Development of a Prototype Laser Point Marking Instrument	AD-673 291 1967
Research in Space Photogrammetry	1961
Research in Surveying, Mapping and Geodesy	AD-230 066 1959-1965
Research Institute Lectures on Geography	ETL-SR-71-1 1971
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Results of Space Triangulation Adjustments from Satellite Data	RN-13 1965
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Review of New Geographic Methods and Techniques, Vol. I	AD-700 151 1969
Review of New Geographic Methods and Techniques, Vol. II	AD-700 176 1969
Review of Photosensitive Materials for Holographic Recordings	ETL-0128 1978
Robotic Vehicle Terrain-Navigation Subsystem: Conceptual Design Phase	ETL-0332 1983
RPIE Symbol Placement Accuracy	ETL-0076 1976
Ruggedized Geodetic SECOR	1964
Ruggedized Geodetic SECOR System	1967
RWPF Spatial Data Study	ETL-0367 1984
Sand and Dust Considerations in the Design of Military Equipment	ETL-TR-72-7 1972
Satellite Angulation	RN-16 1965
Satellite Geodesy Based on Stellar Orientation of Lines Between Unknown Stations	RN-32 1969
Satellite Observations of Widespread Fog	ETL-0361 1984
Satellite-to-Satellite Tracking for Orbit Improvement and Determination of a $10 \times 10$ Gravity Field	ETL-0064 1976
Satellite-to-Satellite Tracking Study for the Global Positioning System (Rotating-Y Configuration)	ETL-SR-74-6 1974
Satellite, U.S. Army Type II, Geodetic	1963
Scale Problems in Geographic Research	ETL-CR-71-16 1971
Scattering from a Vegetation Layer with an Irregular Vegetation Soil Boundary	ETL-0270 1981
Scattering of a Code-Modulated Radio Signal and Associated Multipath Range Errors	ETL-0125 1977
Scene Classification Results Using the Max-Min Texture Measure	ETL-0300 1982
Selected Bibliography of Corps of Engineers Remote Sensing Reports	ETL-0126 1977
Semiautomatic Coordinate Reader	ETL-ETR-71-4 1971
Semi-Automatic Pass Point Determination Using Digital Techniques	ETL-0051 1975
Sensing Array System with Image Statistics Processing, A	ETL-0297 1983
Sequential Independent Model Block Analytical Triangulation (SIMBAT)	AD-805 606L 1966

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Service Tests and Subsequent Modifications and Test of Compass Sun, Universal, 0 to 90 Degrees North and South Latitudes, with Case	1422-TR 1955
Shaded Relief Images for Cartographic Applications	ETL-0259 1981
Side-Looking Radar Data Requirements for Automated Mapping on the UNAMACE	ETL-CR-72-18 1972
Side-Looking Radar Presentation Viewing and Measuring Instrument	22-TR 1965
Signal Signatures of Topographic Features Using Analog Technology	ETL-0185 1979
Simulation of a Radar Image for Garden City Test Site	ETL-0007 1975
Single-Lens, Four-Channel Multiband Camera (Report No. 3 in the ETL Series on Remote Sensing)	ETL-ETR-74-4 1974
Single Photo Analysis of Sampled Aerial Imagery	ETL-RN-74-10 1974
Solution of the General Analytical Aerotriangulation Problem	AD-202 318 1958
Some Relations Between the Geometrical Quality of Topographic Mapping and Aerial Photogrammetry	RN-7 1962
Spatial Light Modulators: Test and Evaluation	ETL-0192 1979
Spatial Sampling: A Technique for Acquisition of Geographic Data from Aerial Photographs and Maps	ETL-CR-71-11 1971
Spectral Reflectivity Data: A Practical Acquisition Procedure	AD-880 049L 1970
Spectral/Spatial Resolution Targets for Aerial Imagery (Report No. 1 in the ETL Series on Remote Sensing)	ETL-TR-74-3 1974
Stable Platform Assembly for Army Artillery Inertial Survey System	AD-681 932 1962
Stable Platform Electronics for Army Artillery Inertial Survey System (GEISHA)	AD-681 933 1962
Star Pattern Recognition and Spacecraft Attitude Determination	ETL-0173 1978
Star Pattern Recognition and Spacecraft Attitude Determination	ETL-0260 1981
Star Pattern Recognition and Spacecraft Attitude Determination, Phase II	ETL-0211 1979
STARAN Image Processing	ETL-0243 1980
Stars' Position Determined by Combining Micrometric Observations with an Observed Known Star in a Vertical Plane Close to the Meridian	RN-20 1967
State-of-the-Art of Slope Mapping	ETL-0060 1976

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Status of Aerial Color Photography in Government Agencies	TB-1 1968
Stereo Analysis of a Specific Digital Model Sampled from Aerial Imagery	ETL-0072 1976
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Stereoscopic Terrain Display for Measurement Applications	ETL-0002 1974
Stress Analysis, Study of the M4 Van Expansible and Adapter, Detachable Running Gear	AD-636 445 1966
Structural Analysis from Radar Imagery, Eastern Panamanian Isthmus	AD-715 322 1970
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